Characterize Pulse Recovery Time and Behavior of LNAs and RF Front Ends

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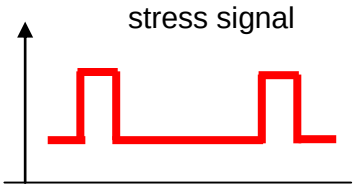
Introduction

- LNAs first input stage often is of sensitive receivers
- LNA is subject to unwanted high input power levels
  - Jamming signals
  - Crosstalk from a radar TX path to RX path
- Typical protection
  - Limiters
  - Switches
  - Degrade performance as sensitivity, bandwidth etc. or require additional control mechanisms

Typical Problem

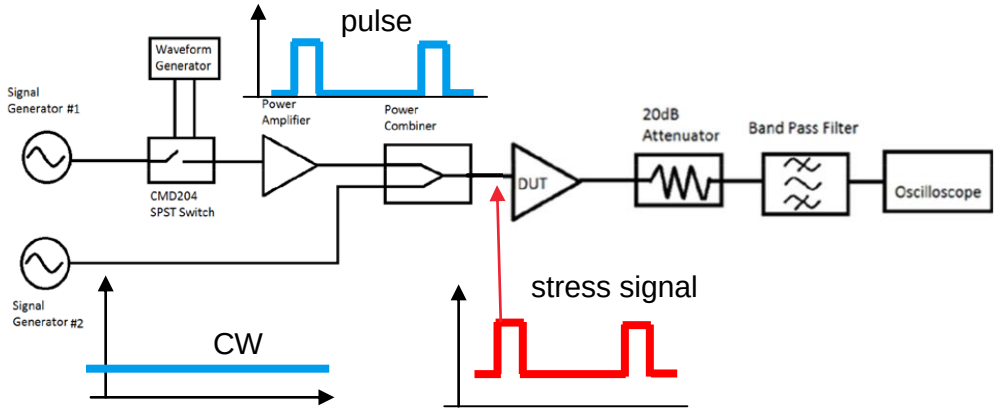
- High power jamming signal or crosstalk signal suddenly switched off
- Amplifier does not recover immediately from compression
- Residual distortion of the desired signal before normal operation returns
- Phenomenon is known as pulse recovery time
- Important parameter for LNAs e.g. in pulsed systems



- The recovery time is measured as the rise time of the wanted small signal from 10% to 90% of the signal level or the desired system performance according to the specifications of the radar system e.g. <0.1 dB 1°

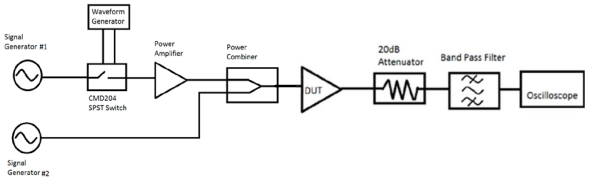
- Pulse recovery time for active devices e.g. GaAs down to 1 us …3 us

Measurement Setup with Generators and Scope



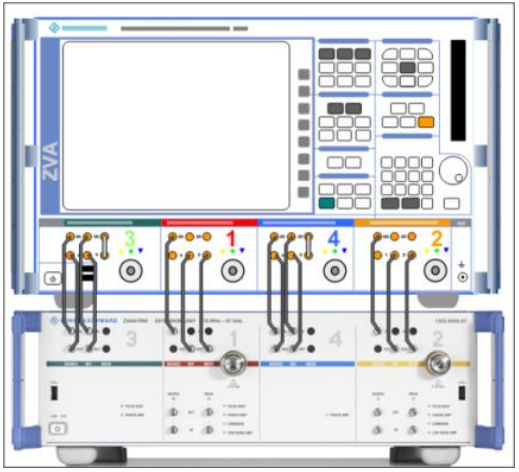
Measurement Setup with Generators and Scope

- Generator 1 for crosstalk or out-of-band jamming signal (offset Δf to gen 2)
- Generator 2 for small signal CW
- Pulsed interfering signal 1 using fast switch or pulse modulator
- Amplification of interference signal if necessary
- Combination of both tones
- Attenuation to small signal level or rejection of out-of band signal via bandpass or bandstop filter

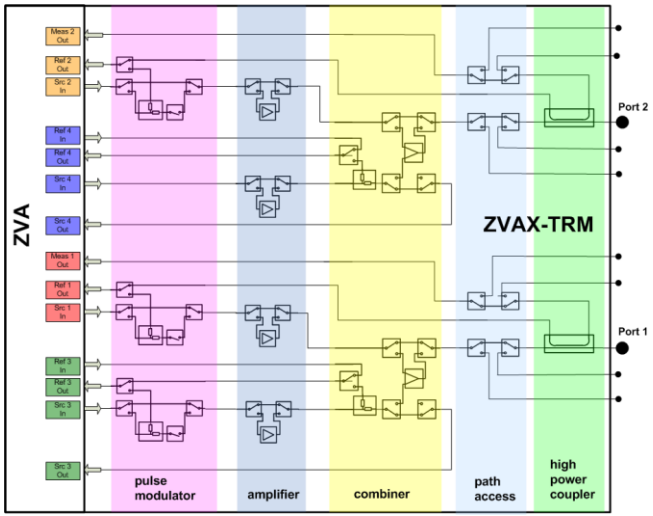


Setup for Pulse Recovery Test based on VNA

- Use of ZVA with 2 or four independent sources
- Extension of ZVA-VNA with ZVAX-TRM
  - Adds combiners, pulse modulators, amplifiers etc
- Control by ZVA via USB
- Pulse generators provided by ZVA

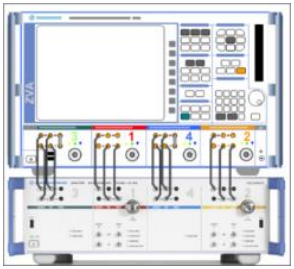


ZVAX-TRM + ZVA



Extends ZVA with:

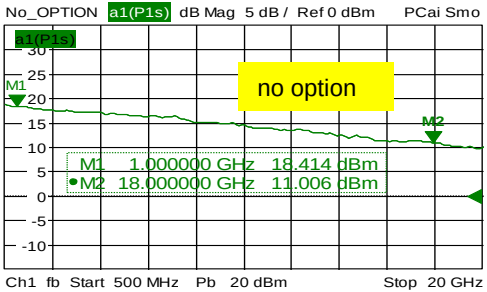
- Pulse modulators
- Amplifiers
- Combiners
- Accesses to source and receiver pathes
- High-power couplers

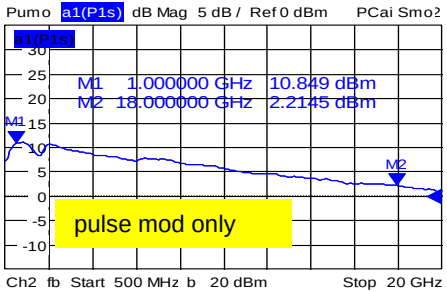


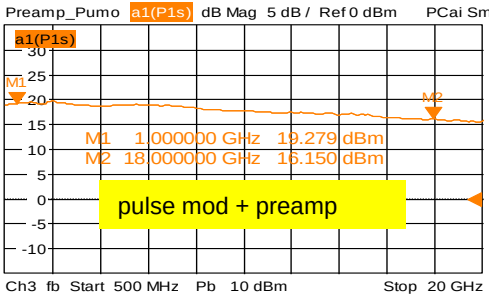
Special Features of ZVAX-TRM

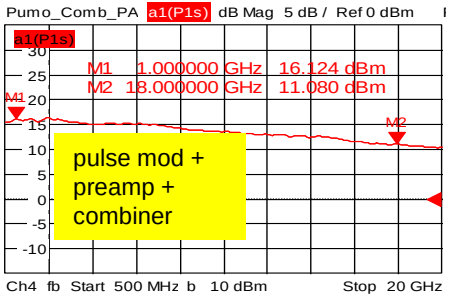
- 3 pulse modulators in 3 source pathes
  - Bidirectional pulse measurments, pulsed intermodulation measurements
  - Control of pulse modulators by pulse generators of ZVA
- Two combiners
  - Intermodulation measurements in two directions
- Internal power amplifier
  - High output power under all conditions
- ZVA with 4 sources
  - Fast intermodulation and mixer measurements
- Switchable access to source and receiver pathes
  - Additional power amplifiers for high power applications
  - Additional LNA for noise figure measurement

High Output Power under all Conditions





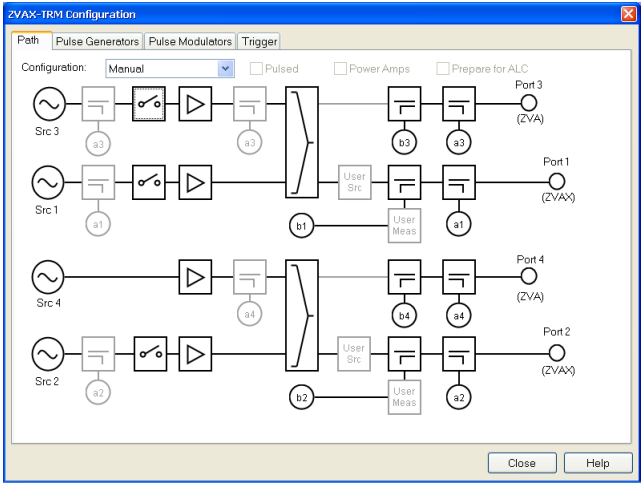




Up to 10 dBm @ 18 GHz with pulse modulator and combiner

Intuitive User Interface

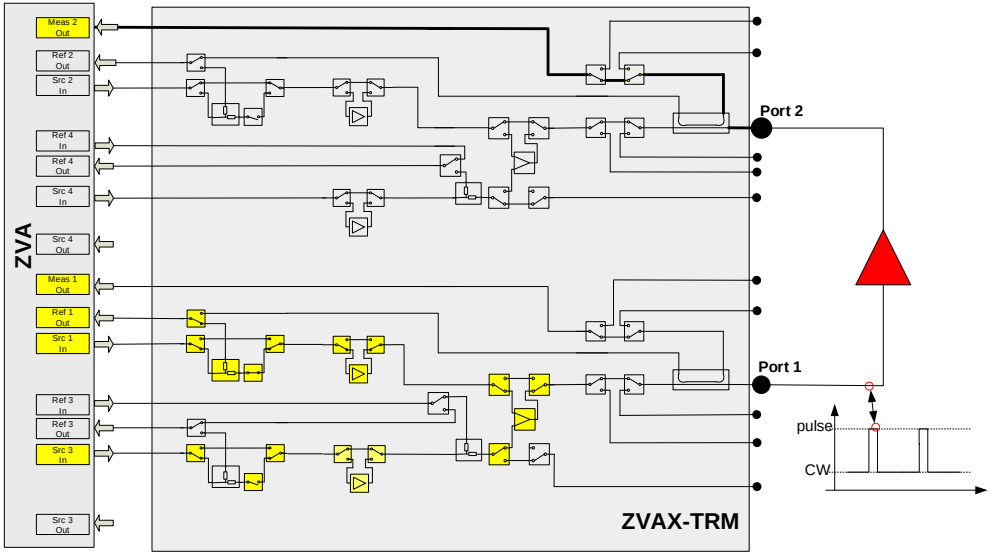
- Controlled directly via ZVA user interface
- Independent settings for different channels – setup for different scenarios



Features for testing Recovery Time Amplifiers

- High power handling up to 43 dBm
- Generation of pulsed signals
  - Measurement in pulsed mode versus frequency, power and time
- Combination of several sources of ZVA
  - Stress signal with small frequency offset to measurement signal
- High output power power due to preamplifiers
- Different pathes to measure the reference signal

Setup for stimulating the DUT



Setup for Generation of Stimulus Scenario

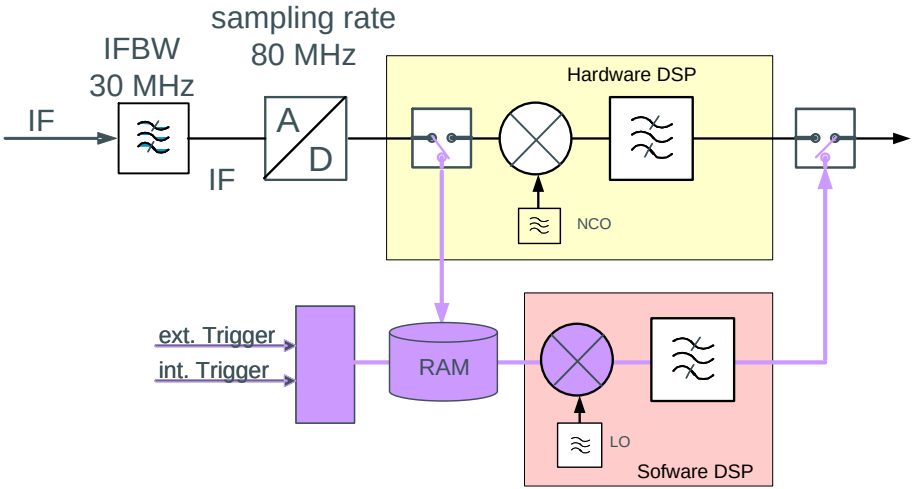
- CW signal from source 1
- Pulse signal from source 3
- Arbitrary pulse withs
- Aribrary frequencies for CW and pulse signal

- Combination of CW and pulsed signal to „stress signal“ via internal combiner

- Stimulation of the DUT

- Measurement of power levels and S-parameters versus time with time resolution of 12.5 ns

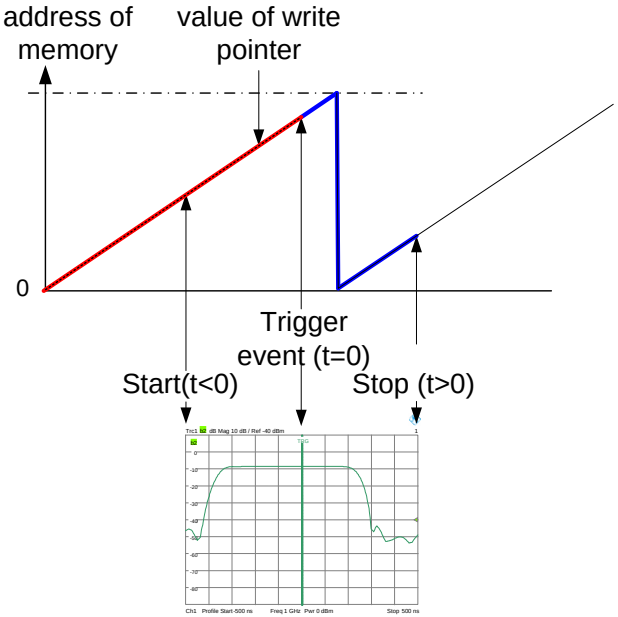
Receiver Architecture for high Time Resolution Pulse Profile Mode of ZVA



Pulse Profile Mode of ZVA

- Sampling data of all wave quantities are stored without filtering in a special memory
- Sampling rate = 12,5 ns (system clock of 80 MHz)
- After end of data recording, digital signal processing e.g. filtering happens not by the DSP but by the software “offline”
- Works with periodic and non-periodic signals
- Does not require any addition hardware

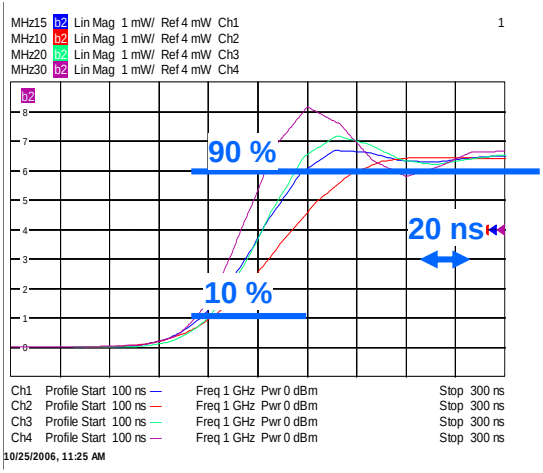
Recording into the Fast - RAM Memory

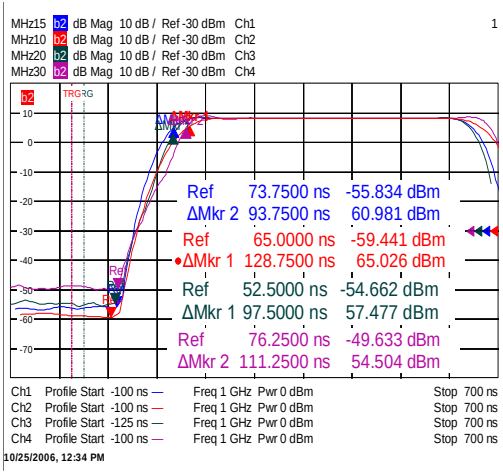


Features of Pulse Profile Mode

- 25 ms of total recording time for S-parameters and wave quantities
- Trigger event establishes t = 0
- Behaviour before trigger event can be detected
- High sweep repetition rate => tuning possible
- Bandwidth up to 30 MHz
- Time resolution 12.5 ns
- Rise time 30 ns

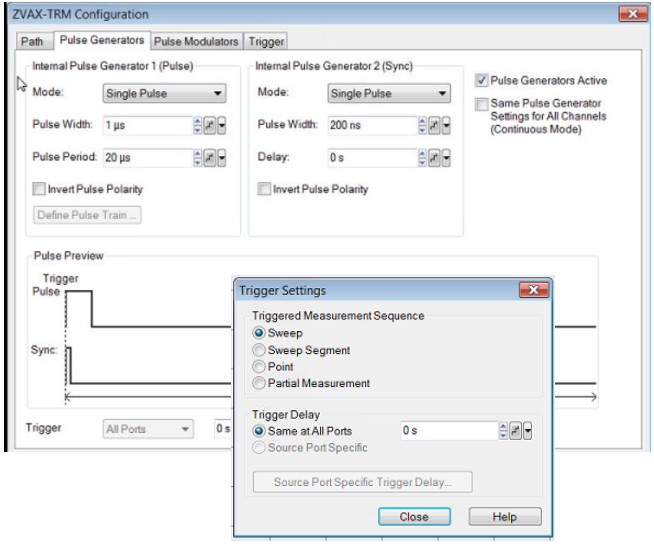
The Rise Time in Pulse Profile Mode





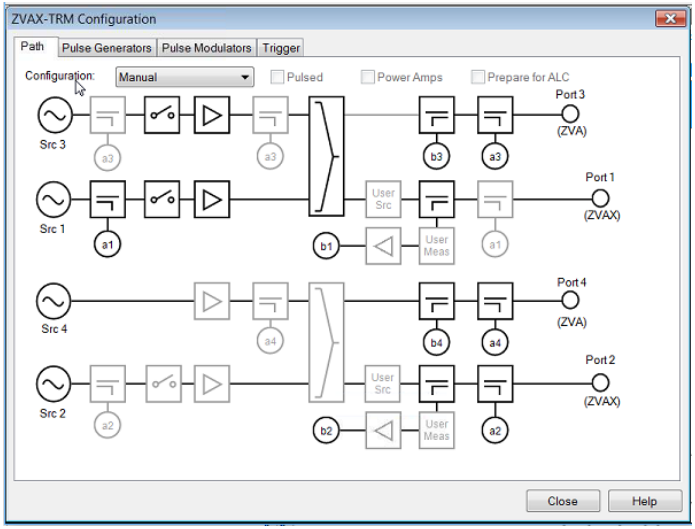
Setup for the Pulse Modulators and Generators

- Use of pulse generator of ZVA to control pulse modulator of source 3
- Pulse width 1us, pulse perion 20 us
- Triggering of ZVA on pulse generator

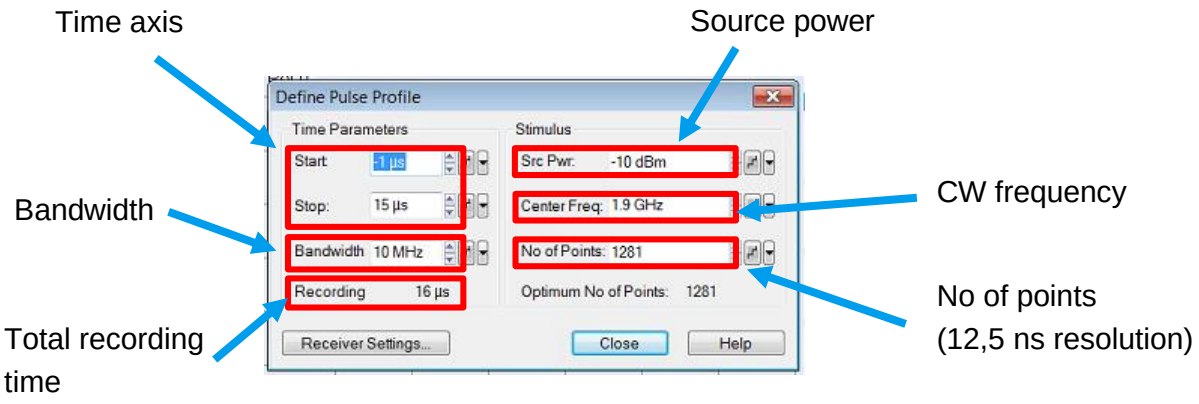


Setup of the ZVAX-TRM Hardware

- Port 3/ source 3
  - Pulse modulator source 3
  - Amplifier for higher output power
- Port 1 / source 1
  - Modulator in Through mode (CW mode)
  - New reference point to avoid a1-receiver compression due to crosstalk of pulse
  - Power amplifier to decouple alternative reference signal from high power pulse signal
- Combiner to generate the stress signal for stimulation



Pulse Profile Receiver Settings

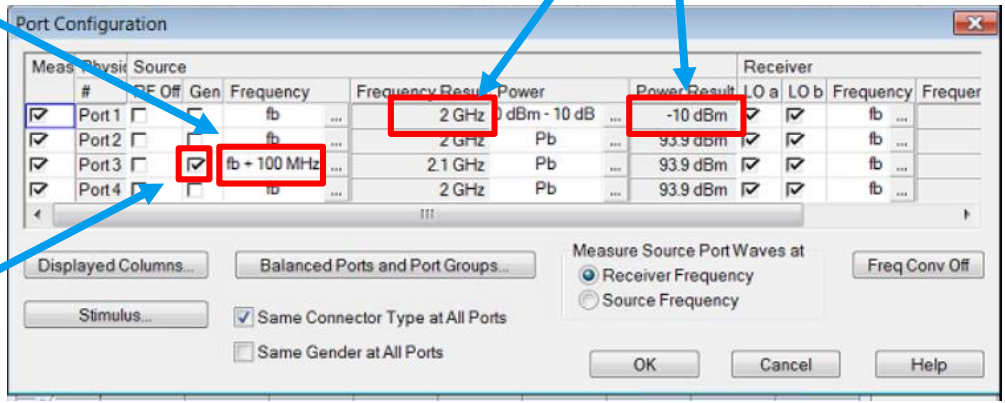


Source Settings

frequency and power of measurement signal

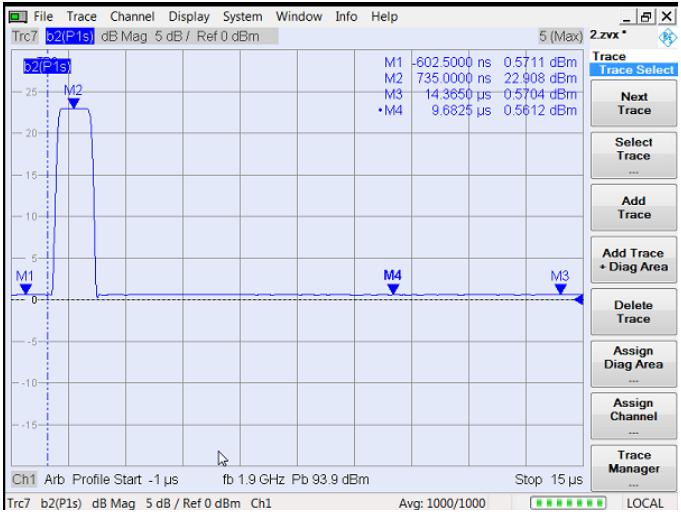
frequency offset of stress signal

permanent drive of stress signal



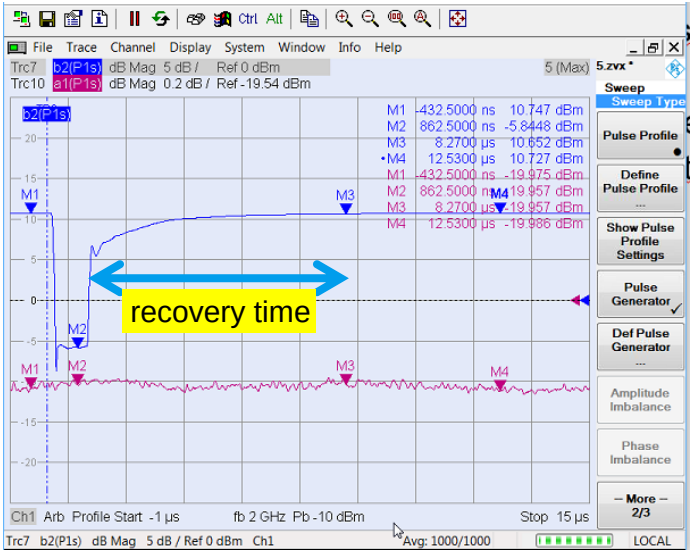
Output power of Jamming Signal versus Time

- Output power with 100 MHz Offset



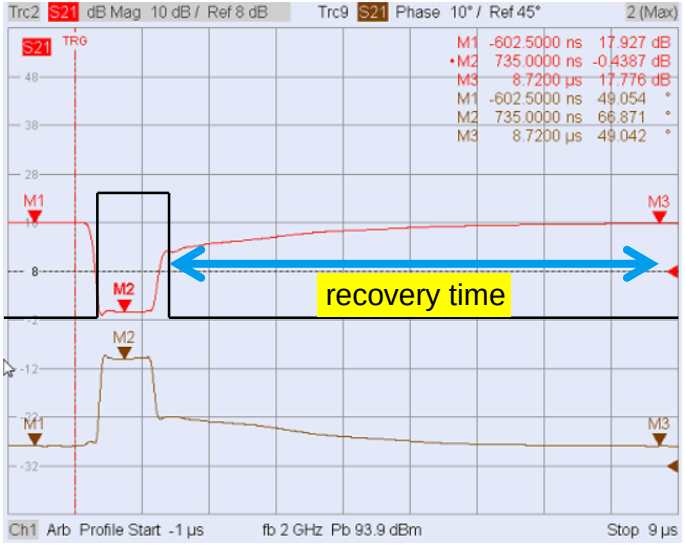
Output and Input Power versus Time

- Drop of output power due to compression
- Measured a1 input power constant due to high isolation of amplifier in source path 1
- 0,1 dB power recovery time 8 us



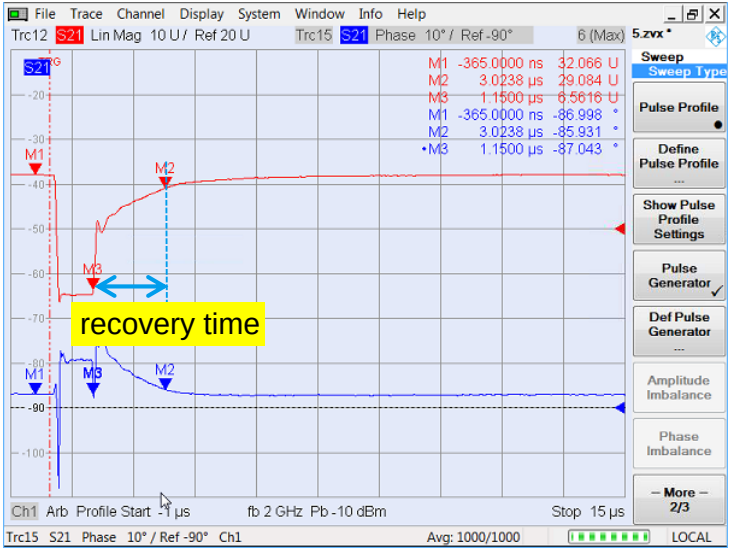
Measurement Results Gain versus time

- Jamming signal drives amplifier into compression (20 dB !)
- After end or jamming signal (1 us) receiver decompresses
- Recovery time for 0,1 dB recovery abt. 8 us
- Phase completely recovered



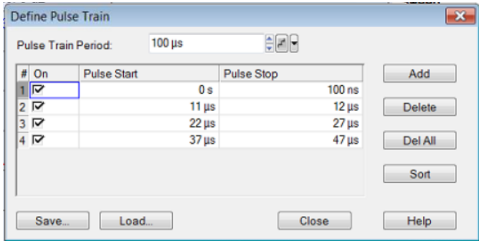
Measurement of Recovery Time for linear Power

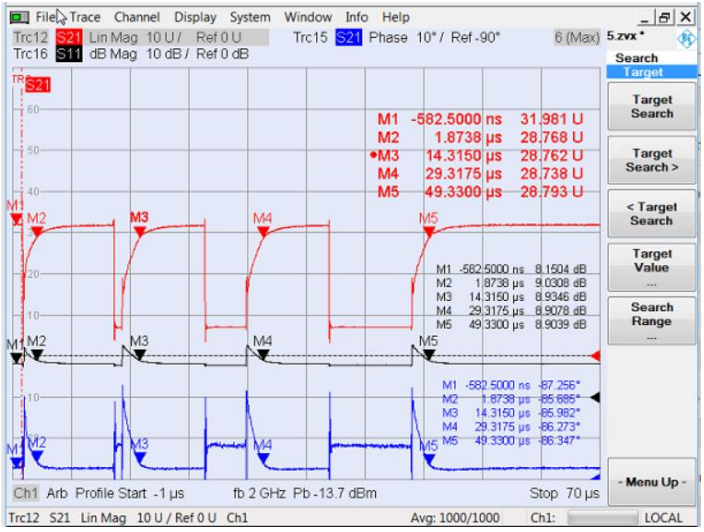
- Measurement of 90% of gain
- Recovery time for 90% of gain 2 us



Special Stress Scenarios

- Using a pulse train
- Pulswidths 100 ns – 5 us - 10 us
- 90% recovery time 9 us





Summary

ZVA + ZVAX-TRM offers plug and play solution for pulse recovery measurements
It offers

- Up to 4 sources for stimulation of the DUT
- Pulse generators and modulators to generate jamming signals
- Pulse train mode to generate individual jamming scenarios
- Power amplifiers to reach high power levels
- Independently sources in respect of frequency and power levels
- Pulse profile mode for time domain analysis with 12.5 ns resolution
- Additional accesses to the receiver path to add filters to suppress the jamming signal to avoid receiver compression

END